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1.0 DESCRIPTION

Introduction

The FP4000 is a battery-operated broadband radio frequency (RF) isotropic electric field probe designed for use in making RF exposure measurements in the vicinity of broadcast facilities and industrial RF sources. This probe uses optical isolation to minimize field perturbation during measurements.

The FP4000 probe measures field strength in each of three axes. It performs a vector addition calculation on the readings and sends the result to the receiver via a fiber optic cable. Data from each axis can be viewed individually, or can be combined. Frequency response of the FP4000 is 10 KHz to 1 GHz; dynamic range is 1 to 300 Volts/meter (V/m).

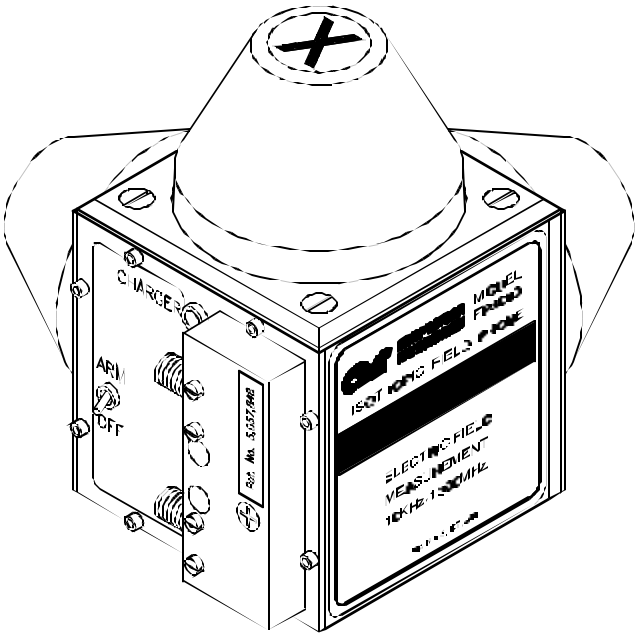

Figure 1-1
FP4000 Electric Field Probe

2.0 FP4000 SPECIFICATIONS

Dynamic Range:	1 to 300 Volts/meter (V/m)
Ranges:	10, 30, 100, 300 Volts/meter full scale
Frequency Response:	10 KHz to 250 MHz ± 0.5 dB 250 MHz to 1.0 GHz ± 1.0 dB
Linearity:	± 0.5 dB full scale (F.S.): ± 2 least significant bits (LSBs) of A/D converter
Isotropicity:	± 0.5 dB
Overload Withstand:	1000 Volts/meter maximum, all ranges
Environmental:	
Operating Temperature:	10 °C to 40 °C (+50 °F to +104 °F)
Humidity:	5% to 95% relative humidity, non- condensing
Fiber Optic Cable Connector:	Standard FSMA
Battery:	3.6 VDC, 1400 mA-h rechargeable Nickel-Cadmium (NiCd)
Battery Charger:	110/220 VAC, 16 hour
Probes:	64 mm (2.5 in) cube with probe shields on three sides
Probe Mount	¼ - 20 UNC tapped hole (internal thread) in base of probe
Weight:	0.4 Kg (14 oz.)
Optional Equipment:	See Table 5-1

3.0 ACCEPTANCE AND CONTROLS

Introduction
This section contains information on: unpacking and acceptance of the FP4000 probe; probe controls; probe connectors; the battery, and; bench testing the battery charger.

Unpacking and Acceptance

Step 1. Upon delivery of your order, inspect the shipping container(s) for evidence of damage. Record any damage on the delivery receipt before signing. In case of concealed damage or loss, retain the packing materials for inspection by the carrier.

Step 2. Remove the probe from its shipping containers. Save the boxes and any protective packing materials for future use.

Step 3. Check all materials against the packing list to verify that the equipment received matches that which was ordered. If you find any discrepancies, note them and call Amplifier Research Customer Service for further instructions.

Be sure that you are satisfied with the contents of your order and the condition of your equipment before installing the probe.

Probe
A switch, two fiber optic connectors and a battery charger connector are mounted on the FP4000 probe housing (Figure 3-1).

XMIT/RCV The fiber optic cable assembly from the receiver is attached to the probe via two connectors. The cable ends are color-coded-white for XMIT, yellow for RCV. Identically-colored dots are located on the probe housing adjacent to these connectors. Be sure that each cable is attached to the proper probe connector.

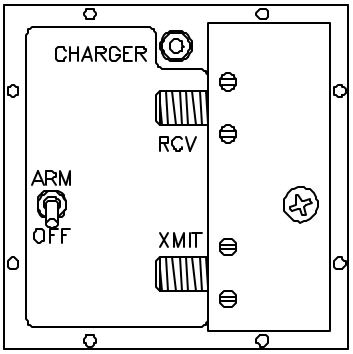

Figure 3-1
Switch and Connectors

When the cables are not attached, always cover the probe connectors with the protective plastic covers supplied with the unit, or with similar material. This prevents dirt and other contaminants from entering the connector, causing communication problems.

ARM/OFF The ARM/OFF switch activates and deactivates the probe. In the ARM position, the probe is powered by its internal 3.6 VDC NiCd battery: in the OFF position, the probe is inactive. To prolong battery life, set this switch to OFF when the probe is not in use.

CHARGER An Amplifier Research BC2002 1 hour Fast Charger is supplied with the FP4000. The Amplifier Research BC2002 manual details the specifications and use of this product.

Battery

The NiCd battery provides up to 40 hours of probe operation when fully charged.

4.0 BATTERY CHARGING

Introduction
Each FP4000 probe contains a rechargeable nickel-cadmium (NiCd) battery. A fully-charged battery (nominal output voltage of 3.6 VDC) provides up to 40 hours of operation. When the battery has discharged to 3.3 VDC, the probe is still operational, but its battery needs charging: when the voltage drops below 3.18 VDC, measurement accuracy will be compromised by further operation.

NOTE

Amplifier Research charges the internal NiCd battery of the FP4000 at the factory in order to calibrate the probe prior to shipment. While every effort is made to ensure that your probe arrives ready to use, we cannot guarantee that this will be the case. Always check the condition of the probe's battery prior to making any measurements.

Charging Procedure

Step 1. Verify that the battery charger is set correctly for the AC voltage in your area.

Step 2. Plug the charger into a suitable AC source.

Step 3. Set the probe switch to OFF. Insert the plug on the charger cable into the probe's CHARGER jack. The indicator on the charger lights up only when a probe is connected.

Step 4. The battery is now charging.

Battery Tips
NiCd batteries have several characteristics that can affect both their performance and operating life. The following tips advise you how to take advantage of these characteristics to get the most out of your probe's battery.

- Although NiCd batteries are rated for operation in temperatures from -20 °C to +65 °C (-4 °F to +140°F), operating the probe in extreme temperatures will reduce operating time significantly. The optimum operating temperature range for these batteries is +20 °C to +30 °C (+68 °F to +86 °F).

- The battery in the FP4000 does not require periodic "deep discharges" to reverse the capacity-depleting "memory effect" caused by repeated shallow discharges; however, undercharging can reduce battery capacity. Therefore, after the charging procedure is complete, be sure that the battery is fully charged before resuming field operation.

- If the battery exhibits low terminal voltage during charging, or if it appears unable to acquire or maintain an appreciable charge, individual cells in the battery may be shorted or damaged. If, for any reason, your battery needs replacement, contact Amplifier Research Customer Service for assistance.

5.0 MAINTENANCE

Introduction
This section explains which maintenance tasks can be performed by the user. It also provides information regarding replacement and optional parts. If you have any questions concerning probe maintenance, consult Amplifier Research Customer Service.

Maintenance Recommendations
Maintenance of the FP4000 is limited to external components such as cables or connectors.

Any calibration or maintenance task which requires probe disassembly should be performed at the factory. Check with Amplifier Research Customer Service (215-723-0275) before opening the unit to avoid problems with your probe's warranty.

NOTE

Opening the probe enclosure may void your warranty. If your system is under warranty, contact Amplifier Research Customer Service before performing any maintenance inside the probe.

Return Procedures
To return a probe to Amplifier Research, use the following procedure:

Step 1. Briefly describe the problem in writing. Give details regarding the observed symptom(s), and whether the problem is constant or intermittent in nature. If you have talked previously to Amplifier Research Customer Service about the problem, provide the date(s), the name of the service representative you spoke with, and the nature of the conversation. Include the serial number of the item being returned.

Step 2. Package the probe carefully. Use the original boxes and packing materials, if possible.

NOTE

If your probe is calibrated in accordance with MIL-Std-45662A, it is greatly to your benefit to retain the original shipping box and packing materials. One of the criteria for certifying a calibration to MIL standards requires Amplifier Research to always ship equipment in the specified packaging. When a MIL Standard instrument is sent to Amplifier Research in other packaging, we must replace it with the specified packaging materials for return shipment. YOU WILL BE BILLED FOR THE NEW PACKAGING.

If the probe is still under warranty, refer to the Limited Warranty in this manual for additional information about your return.

Periodic/Preventive Maintenance
Amplifier Research recommends an annual calibration check of the FP4000 probe to verify that it is performing within specifications. This calibration check may be performed by Amplifier Research. Contact Amplifier Research Customer Service (215-723-0275) for price, scheduling and shipping information.

Parts Information

Use the following table (Table 5-1) for ordering replacement or optional parts for the FP4000.

Table 5-1. Replacement/Optional Parts List

Part Description (Replacement Parts)	Part Number
Universal 3.6V Fast Charger (110/240 Volt) (BC2002)	1010956-501
FP4000 User's Manual	1007506
Cable, Fiber Optic, Glass, 10 Meter (FP2010)	1004602-501
Probe Stand Assembly (PS2000)	1005800-501
Fiber Optic / RS232 Interface (IF4000)	1007449-501

6.0 THEORY OF OPERATION

Introduction
This section discusses the theory of operation and the functions of the FP4000 Isotropic Electric Field Probe. A high-level block diagram (Figure 6-1) is included to aid the discussion. The objective is to provide information that enhances the user's understanding of the design of this probe.

For detailed information on specific circuits, refer to the schematic diagram at the back of this manual.

System Theory
The FP4000 Isotropic Electric Field Probe utilizes a microprocessor for intelligent operation and control. The probe's self-contained power supply employs a 3.6 VDC NiCd battery, which provides up to 40 hours of continuous operation.

For each axis, the probe measures the radio frequency signal level and generates a linearized reading of the measurement. A vector addition is performed on these three readings: the resultant is transmitted to the receiver over glass fiber optic cables. The probe provides data via either a short form or long form output word. See Appendix B for details on both output word formats.

Probe Operation
Receiver commands to the probe consist of the following:

- Send reading
- Zero
- Change range
- Enable/disable axis
- Read battery voltage
- Set sleep timer
- Read temperature

The signal flow within the probe is shown in the block diagram.

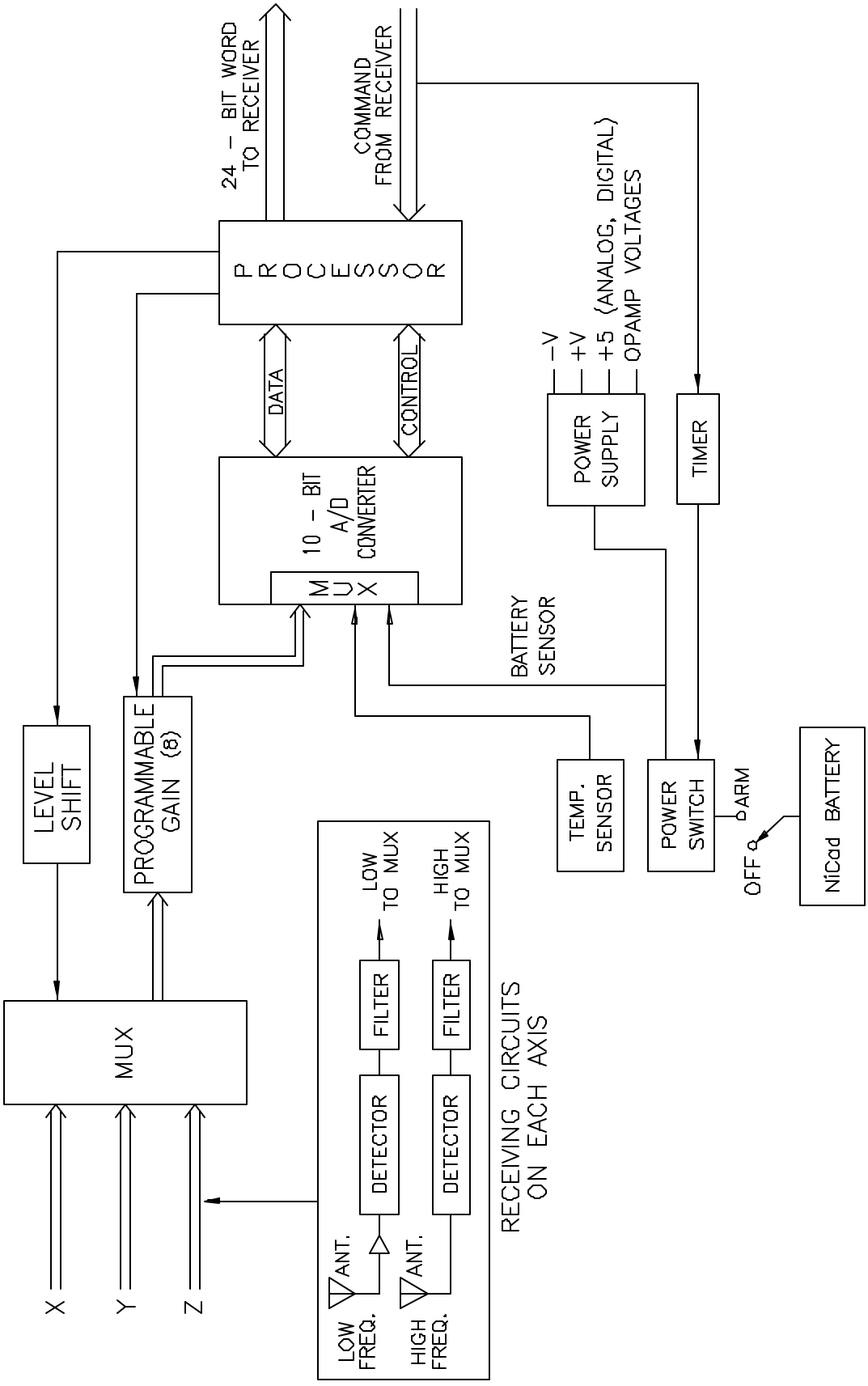

Figure 6-1 Probe Block Diagram

To measure field strength, three sets of mutually orthogonal monopole antennas are used to provide an isotropic response to the ambient field. The probe uses two antennas per axis-one each for high and low frequencies-to receive RF signals. The signals are fed to a Schottky diode detector (low frequency signals are preamplified first). After filtering and amplification, the high and low frequency signals generated by each axis (a total of six signals) are fed into the multiplexer.

The microprocessor instructs the multiplexer to look at each of the six axis signals sequentially. A time-division output signal from the multiplexer is fed into the programmable gain stage.

The programmable gain stage provides the required amplification factors for the high and low frequency signals on each range. The system uses four ranges (10, 30, 100, and 300 V/m): each range requires both a high and low frequency gain setting-eight amplification factors in all.

For example, assume the probe is making measurements using the 100 V/m range. When the multiplexer selects the low frequency X axis signal, the microprocessor directs the programmable gain stage to use the appropriate amplification factor for this signal. This process is repeated for the next signal sample (X high) as well as for the four remaining axis signals. The output of the gain stage feeds the multiplexed front end of the analog-to-digital (A/D) converter.

After stepping through all six axis signals, the microprocessor commands the multiplexed A/D front end to read the battery voltage and temperature sensing lines. An entire A/D cycle, therefore, consists of eight readings.

The eight readings from the A/D converter are input to the microprocessor, which performs a vector sum calculation on the X, Y and Z channels. This data is transmitted.

Probe Power Supply

The probe is powered by a sealed rechargeable 3.6 VDC NiCd battery, which drives both the analog and digital power supplies; the FP4000 employs separate power sources to provide isolation between the analog and digital circuitry. With the probe switch in the ARM position, voltage from the battery is applied to the power switch. This switch routes the battery voltage to the power supply, enabling the microprocessor. The power switch is controlled by a timer circuit. The timer monitors the fiber optic connector input line to determine whether the probe has received a command during a specified period (several seconds). If no command is received during this period, the timer signals the power switch to disable the power supply and the microprocessor. In essence, the probe goes dormant to conserve battery power: only the fiber optic input circuitry remains active in order to detect new commands. When the next command reaches the probe, power is reapplied automatically and the processor is reactivated, "waking up" the probe.

NOTE

The probe uses volatile random access memory (RAM). If, for any reason, power to the probe is lost, the probe must be re-zeroed.

Zeroing

When the zero command is sent, the probe must be in a zero field environment. This is because the zero command causes the multiplexer (via the processor) to perform a normal read cycle on all axis signals. This procedure is executed for all 24 ranges (four ranges, three axes per range, two antennas per axis). When the processor receives all the zero-field signal values, it stores them in a special register; these values are subtracted from all subsequent measurements. Therefore, a probe which is zeroed while it is not in a zero field environment will give erroneous readings.

7.0 APPLICATION CONSIDERATIONS

Introduction
The following subsections contain information designed to help you maximize the effectiveness of the FP4000 probe.

Out-of-Band Considerations
Although the specified operating range of the FP4000 is from 10 KHz to 1 GHz, it responds to signals both above and below these frequencies. Such responses must be taken into account when performing certain operations, such as zeroing.

On the low frequency end, the FP4000 is specified to operate down to 10 KHz; however, the probe can exhibit some response to frequencies as low as 50/60 Hz. Such an out-of-band response poses a problem when zeroing the unit, since this operation obviously assumes a zero field condition. Therefore, when zeroing, the user must compensate accordingly for any low frequency out-of-band response.

At the upper end, similar problems can occur. The specified upper operating limit is 1 GHz. Above this frequency, the dimensions of the probe body itself become appreciable in relation to wavelength: this makes the behavior of the FP4000 unpredictable above 1 GHz. Responses to frequencies up to 6 GHz must be compensated for when zeroing the probe.

Resolution Limitations
Limitations in system resolution may result in a non-zero reading when the receiver is zeroed. If this occurs, it does *not* necessarily mean that your readings are inaccurate. Probe linearity is specified as ± 0.5 dB full scale: in addition, the variance of the probe's A/D converter is ± 2 least significant bits. When using the most sensitive range (10 V/m), these specifications create the possibility that, under zero field conditions, the receiver may display a non-zero value.

Probe Support Structures
It is *very* important to keep conductive objects away from the FP4000. Any such objects in the proximity of the probe may distort the near field and compromise measurement accuracy. If your application requires measurements from a fixed position, always mount the probe on a non-metallic platform, using non-metallic screws.

APPENDIX A
FP4000 ERROR CODES

Probe Error Output

If an error occurs, the probe will respond with one of the following strings. These strings begin with a colon and end with a carriage return.

E01 Communication error (e.g., overflow).

E02 Buffer full error. Too many characters contained between the Start Character/Carriage Return sequence.

E03 The received command is not valid.

E04 The received parameter is not valid.

E05 Hardware error (e.g., EEPROM failure).

E06 Parity error.

APPENDIX B
FP4000 OPERATING PROTOCOLS

Introduction

The information in this appendix assumes that you have purchased the optional IF4000 Fiber Optic / RS232 Interface, and are capable of communicating directly with the FP4000 probe.

Communication Protocol

Data Type:	RS-232 Serial
Data Mode:	Asynchronous
Word Length:	7 bit
Parity:	Odd
Stop Bits:	1
Data Rate:	9600 baud

Information Transfer Protocol

The FP4000 operates as a Controller Mode device. It only responds to commands from another device; it transmits no data without first receiving instructions to do so.

Command Structure

A command to an FP4000 probe consists of 1) a command letter, followed by 2) possible parameters, 3) terminated with a carriage return. When it completes the command, the FP4000 responds with a string consisting of 1) a start character (":"), 2) the command letter, followed by 3) data, if required, and terminated with 4) a carriage return. If the command does not require the probe to return any data, the probe simply responds with the command letter and a carriage return. If an error occurs, the probe responds with an error code, as detailed in Appendix A.

Commands

Command	Description
Axxx	**Axis enable/disable.** x = "E" means enable, x = "D" means disable. xxx order is X axis, Y axis, Z axis
B	**Read battery voltage**.
Cx	**Set baud rate.** x = 1 sets rate to 2400 baud x = 2 sets rate to 9600 baud Note that the baud rate does not change until the FP4000 has been powered down (turned off), let sit for at least 10 seconds, and then powered up (turned on) again.
Dx	**Read probe data.** x = 1 enables short form output

x = 2 enables long form output

Rx **Set range.** x = 1, 2, 3, 4 or N (next range)

Sx **Sleep timer.** x = number of seconds to wait for a command before putting the probe into the sleep mode. In the sleep mode, the FP4000 changes to a low power mode which increases battery life. In the sleep mode, the probe can only recognize the receipt of a command; it cannot recognize a command. The first command sent when the probe could be in a sleep mode may be an ASCII null character or any command. Following the receipt of this "wakeup" character, a command can be sent to which the probe will respond.

Tx **Read Temperature.** x = C or F

Ux **Set unit type.** x = 1, 2, 3, or N (next unit)

1 = V/m
2 = mW/cm²
3 = [V/m]²

Z **Zero.**

Null **Send the ASCII null character.** This is a special command that can be used as the initial command to the probe after it is turned on. The probe responds with "N".

NOTE:

When remotely operating the probe using commands manually entered from a computer keyboard, the FP4000 may "go to sleep" between commands. This may be noted when the **Sleep Timer** is set to a short interval such as one or two seconds. When this happens, the probe may seem to be unresponsive to commands or may seem to skip commands.

If this condition is observed, send an **S0** command and keep sending the command as fast as possible until the probe responds (**:S**) and the sleep timer is turned off. Now the probe will respond in the proper manner.

Probe Output

Command	FP4000 Response
B	**Bxx.xx,** where xx.xx is the battery voltage.
D1	**Dxx.xxuuu**, the short form output. xx.xx is the reading. The position of the decimal point depends upon the range setting of the FP4000. uuu = units _V_ = V/m, mW2 = mW/cm², _V2 = [V/m]² (underscore indicates a space character).
D2	**Dxx.xxuuurrrobaaat**, the long form output. xx.xx = the reading, as described for D1. uuu = units, as describe for D1. rrr = recorder out value (A 3-digit ASCII number from 0 to 255). o = over range indicator ("N" = ok, "O" = over range). b = battery status ("N" = safe operating level, "W" = warning level, "F" = fail level). aaa = axis enable ("E" = enabled, "D" = disabled). Axis order is X, Y, Z. t = terminating carriage return.
Rx	**Rx**, where x is the range. x = "" returns the range currently in use x = 1, 2, 3, 4 enables the selected range x = N sets the probe to the next (higher) range.
TF	**Txxx**, where xxx is temperature in º Fahrenheit.
TC	**Txxx**, where xxx is temperature in º Centigrade.

NOTE: "Compiled executable version available upon request"

APPENDIX C
FP4000 QUICKBASIC EXAMPLE COMMUNICATIONS PROGRAM

QuickBasic Code

```
'FP4000 Driver
'Version 1.0

REM **
REM **  the next lines open RS-232 for communication with FP4000
REM **  either on com1 or com2
REM **
DO
  CLS
    PRINT : PRINT : PRINT
    PRINT "       Com port configuration for FP4000"
    PRINT
    PRINT "       1.  COM1"
    PRINT "       2.  COM2"
    PRINT
    INPUT "       Selection (1-2)? ", ComSelect$
LOOP UNTIL (ComSelect$ = "1" OR ComSelect$ = "2")
SELECT CASE ComSelect$
  CASE "1"
    OPEN "COM1:9600,O,7,1,RS,CS0,DS0" FOR RANDOM AS #1
  CASE "2"
    OPEN "COM2:9600,O,7,1,RS,CS0,DS0" FOR RANDOM AS #1
END SELECT

REM
REM ** the next lines wake the FP4000 if it is currently in sleep
REM ** mode, and set the sleep timer to zero, which disables
REM ** the sleep timer.
REM **
PRINT : PRINT : PRINT
PRINT "       Setting up FP4000..."
PRINT
PRINT #1, "S0"; CHR$(13)
SLEEP 1
PRINT #1, "S0"; CHR$(13)
SLEEP 1
PRINT #1, "S0"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Sleep$ = INPUT$(1, #1)
  Result$ = Result$ + Sleep$
```

```
LOOP
WIDTH #1, 255

REM **
REM ** The main menu lets you choose from the diagnostic routine or
REM ** the simple driver that takes data, etc.
REM **
MainMenu:
    DO
      DO
        CLS
        PRINT : PRINT : PRINT
        PRINT "           FP4000 Main Menu"
        PRINT
        PRINT "       1.  Diagnostics"
        PRINT "       2.  FP4000 Driver"
        PRINT
        INPUT "       Selection (1-2) or (Q)uit? ", MainChoice$
      LOOP UNTIL ((MainChoice$ = "1") OR (MainChoice$ = "2") OR (MainChoice$ = "Q") OR (MainChoice$ = "q"))
      SELECT CASE MainChoice$
        CASE "1"
          GOSUB Diagnostics
        CASE "2"
          GOSUB DriverMenu
        CASE "Q"
          GOTO Quit
        CASE "q"
          GOTO Quit
      END SELECT
    LOOP UNTIL (MainChoice$ = "Q" OR MainChoice$ = "q")

REM **
REM **  The diagnostic routine sends various commands and requests
REM **  responses to ensure that the FP4000 is working correctly, and
REM **  if errors are encountered, provides information about where
REM **  the problem may be occurring.
REM **
Diagnostics:
    CLS
    DiagnosticErrorCount = 0
    PRINT
    PRINT "Testing....."

    REM ** The next lines sends the command to receive battery
    REM ** voltage and reads the serial port to ensure that the
    REM ** correct response was given by the FP4000.
    REM **
    PRINT #1, "B"; CHR$(13)
    PRINT "Battery Voltage:    ";
    SLEEP 1
    Result$ = ""
    DO WHILE NOT EOF(1)
      Voltage$ = INPUT$(1, #1)
      Result$ = Result$ + Voltage$
    LOOP
    IF INSTR(Result$, ":B") = 0 THEN
```

```
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

REM **
REM **  The next lines test the temperature request command
REM **
PRINT #1, "TC"; CHR$(13)
PRINT "Temperature:       ";
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Temperature$ = INPUT$(1, #1)
  Result$ = Result$ + Temperature$
LOOP
IF INSTR(Result$, ":T") = 0 THEN
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

REM **
REM ** The next lines test the zeroing command.
REM **
PRINT #1, "Z"; CHR$(13)
PRINT "Zero:              ";
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Zero$ = INPUT$(1, #1)
  Result$ = Result$ + Zero$
LOOP
IF INSTR(Result$, ":E") <> 0 THEN
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

REM **
REM ** The following lines set the X, Y, and Z axis to a
```

```
REM ** particular setting, then checks to see if what was
REM ** expected happened.  This is then repeated with a
REM ** different value and rechecked.
REM **
ErrorFlag = 0
AxisSend$ = "ADDD" + CHR$(13)
PRINT "Axis:              ";
PRINT #1, AxisSend$
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Axis$ = INPUT$(1, #1)
  Result$ = Result$ + Axis$
LOOP
PRINT #1, "D2"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Axis$ = INPUT$(1, #1)
  Result$ = Result$ + Axis$
LOOP
IF INSTR(Result$, "DDD") = 0 THEN
  ErrorFlag = 1
END IF
AxisSend$ = "AEEE"
PRINT #1, AxisSend$; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Axis$ = INPUT$(1, #1)
  Result$ = Result$ + Axis$
LOOP
PRINT #1, "D2"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Axis$ = INPUT$(1, #1)
  Result$ = Result$ + Axis$
LOOP
IF INSTR(Result$, "EEE") = 0 THEN
  ErrorFlag = 1
END IF
IF ErrorFlag = 1 THEN
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

REM **
REM ** These next lines checks the range setting capability
REM ** with a similar method to the above routine for the axes.
```

```
REM **
PRINT #1, "R2"; CHR$(13)
PRINT "Range:              ";
SLEEP 1
ErrorFlag = 0
Result$ = ""
DO WHILE NOT EOF(1)
  Range$ = INPUT$(1, #1)
  Result$ = Result$ + Range$
LOOP
PRINT #1, "R"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Range$ = INPUT$(1, #1)
  Result$ = Result$ + Range$
LOOP
IF INSTR(Result$, "R2") = 0 THEN
  ErrorFlag = 1
END IF
PRINT #1, "R1"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Range$ = INPUT$(1, #1)
  Result$ = Result$ + Range$
LOOP
PRINT #1, "R"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Range$ = INPUT$(1, #1)
  Result$ = Result$ + Range$
LOOP
IF INSTR(Result$, "R1") = 0 THEN
  ErrorFlag = 1
END IF
IF ErrorFlag = 1 THEN
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

REM **
REM ** These next lines check the unit type setting command.
REM **
ErrorFlag = 0
PRINT #1, "U2"; CHR$(13)
PRINT "Unit Type:          ";
SLEEP 1
Result$ = ""
```

```
DO WHILE NOT EOF(1)
  Unit$ = INPUT$(1, #1)
  Result$ = Result$ + Unit$
LOOP
PRINT #1, "D2"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Unit$ = INPUT$(1, #1)
  Result$ = Result$ + Unit$
LOOP
IF INSTR(Result$, "MW2") = 0 THEN
  ErrorFlag = 1
END IF
PRINT #1, "U1"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Unit$ = INPUT$(1, #1)
  Result$ = Result$ + Unit$
LOOP
PRINT #1, "D2"; CHR$(13)
SLEEP 1
Result$ = ""
DO WHILE NOT EOF(1)
  Unit$ = INPUT$(1, #1)
  Result$ = Result$ + Unit$
LOOP
IF INSTR(Result$, " V ") = 0 THEN
  ErrorFlag = 1
END IF
IF ErrorFlag = 1 THEN
  COLOR 4, 0, 0
  PRINT "ERROR"
  COLOR 7, 0, 0
  DiagnosticErrorCount = DiagnosticErrorCount + 1
ELSE
  COLOR 2, 0, 0
  PRINT "OK"
  COLOR 7, 0, 0
END IF

PRINT

REM **
REM ** the next lines determines if any errors were encountered
REM ** and displays the appropriate information.
REM **
IF (DiagnosticErrorCount = 0) THEN
  PRINT "This FP4000 appears to be working normally."
ELSE
  PRINT "Please write down this information and contact your local"
  PRINT "representative or the Customer Service department at"
  PRINT "Amplifier Research.  Refer to your FP4000 manual for that"
  PRINT "information."
END IF
```

```
    PRINT
    INPUT "Press Enter to return to the Main Menu.", Continue$
    RETURN

REM **
REM ** the following lines display the choices available if the
REM ** selection for the driver was chosen, and processes the chosen
REM ** selection.
REM **
DriverMenu:
    DO
      DO
        CLS
        GOSUB InitVar
        PRINT : PRINT : PRINT
        PRINT "          FP4000 Driver Menu"
        PRINT
        PRINT "       1.  Read battery voltage"
        PRINT "       2.  Read temperature"
        PRINT "       3.  Zero"
        PRINT "       4.  Axis enable/disable"
        PRINT "       5.  Set range"
        PRINT "       6.  Set unit type"
        PRINT "       7.  Read probe data"
        PRINT "       8.  Set sleep timer"
        PRINT "       9.  Set baud rate"
        PRINT "       Q.  Quit"
        PRINT
        INPUT "       Selection (1-9)? ", DriverChoice$
      LOOP UNTIL (DriverChoice$ >= "1" AND DriverChoice$ <= "9" OR DriverChoice$ = "Q" OR DriverChoice$ = "q")
      SELECT CASE DriverChoice$
        CASE "1"
          GOSUB Battery
        CASE "2"
          GOSUB Temperature
        CASE "3"
          GOSUB Zero
        CASE "4"
          GOSUB AxisEnable
        CASE "5"
          GOSUB Range
        CASE "6"
          GOSUB Unit
        CASE "7"
          GOSUB ReadData
        CASE "8"
          GOSUB SleepTimer
        CASE "9"
          GOSUB BaudRate
      END SELECT
    LOOP UNTIL (DriverChoice$ = "Q" OR DriverChoice$ = "q")
    RETURN

REM **
REM ** the following lines request and display the battery voltage
```

```
REM **
Battery:
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Requesting battery voltage from FP4000..."
    PRINT
    'Send battery volt request to FP4000
    PRINT #1, "B"; CHR$(13)
    SLEEP 1
    PRINT "       Battery Voltage: ";
    Result$ = ""
    DO WHILE NOT EOF(1)
      Voltage$ = INPUT$(1, #1)
      Result$ = Result$ + Voltage$
    LOOP
    PRINT Result$: PRINT
    PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines request and display the temperature
REM **
Temperature:
    DO
      CLS
      PRINT : PRINT : PRINT
      PRINT "          Request temperature"
      PRINT
      PRINT "       1.  Temperature in Celsius"
      PRINT "       2.  Temperature in Fahrenheit"
      PRINT
      INPUT "       Selection (1-2)? ", TempChoice$
    LOOP UNTIL (TempChoice$ = "1" OR TempChoice$ = "2")
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Requesting temperature from FP4000..."
    PRINT
    'Send temperature request to FP4000
    SELECT CASE TempChoice$
      CASE "1"
        PRINT #1, "TC"; CHR$(13)
        SLEEP 1
      CASE "2"
        PRINT #1, "TF"; CHR$(13)
        SLEEP 1
    END SELECT
    PRINT "       Temperature: ";
    Result$ = ""
    DO WHILE NOT EOF(1)
      Temperature$ = INPUT$(1, #1)
      Result$ = Result$ + Temperature$
    LOOP
    PRINT Result$: PRINT
    PRINT
```

```
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines send the zero command to the FP4000
REM **
Zero:
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Zeroing FP4000..."
    PRINT #1, "Z"; CHR$(13)
    SLEEP 1
    Result$ = ""
    DO WHILE NOT EOF(1)
      Zero$ = INPUT$(1, #1)
      Result$ = Result$ + Zero$
    LOOP
    IF INSTR(Result$, ":E") = 0 THEN
      PRINT "       FP4000 zeroed successfully"
    ELSE
      PRINT "       An error has occurred in zeroing the FP4000"
    END IF
    PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines allow the operator to enter enable or
REM ** disable commands for each axis and sends the corresponding
REM ** command to the FP4000
REM **
AxisEnable:
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Type 'E' for enable or 'D' for disable"
    PRINT
    INPUT "       X axis: ", XAxis$
    XAxis$ = UCASE$(XAxis$)
    INPUT "       Y axis: ", YAxis$
    YAxis$ = UCASE$(YAxis$)
    INPUT "       Z axis: ", ZAxis$
    ZAxis$ = UCASE$(ZAxis$)
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Enabling/disenabling axes..."
    PRINT
    AxisSend$ = "A" + XAxis$ + YAxis$ + ZAxis$
    PRINT #1, AxisSend$; CHR$(13)
    SLEEP 1
    Result$ = ""
    DO WHILE NOT EOF(1)
      Axis$ = INPUT$(1, #1)
      Result$ = Result$ + Axis$
    LOOP
```

```
    IF INSTR(Result$, ":E") = 0 THEN
      PRINT "       Axes enabled/disabled successfully"
    ELSE
      PRINT "       An error has occurred in enabling/disabling axes"
      INPUT "       Press Return to continue ", Continue$
    END IF
    PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines allows the operator to choose which range
REM ** to set the FP4000 to, and sends the appropriate command.
REM **
Range:
    DO
      CLS
      PRINT : PRINT : PRINT
      PRINT "       Select FP4000 range"
      PRINT
      PRINT "       1, 2, 3, 4, or [N]ext range"
      INPUT "       Selection (1-4 or N)? ", RangeChoice$
    LOOP UNTIL (RangeChoice$ >= "1" AND RangeChoice$ <= "4" OR RangeChoice$ = "n" OR RangeChoice$ = "N")
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Setting range..."
    PRINT
    PRINT #1, "R"; RangeChoice$; CHR$(13)
    SLEEP 1
    Result$ = ""
    DO WHILE NOT EOF(1)
      Range$ = INPUT$(1, #1)
      Result$ = Result$ + Range$
    LOOP
    IF INSTR(Result$, ":E") = 0 THEN
      PRINT "       Range selected successfully"
    ELSE
      PRINT "       An error has occurred in selecting the range"
      INPUT "       Press Return to continue ", Continue$
    END IF
    PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines allows the operator to select which unit type
REM ** to set the FP4000 to and sends the appropriate command.
REM **
Unit:
    DO
      CLS
      PRINT : PRINT : PRINT
      PRINT "       Select a unit type"
      PRINT
```

```
      PRINT "       1.  V/m"
      PRINT "       2.  mW/cmý"
      PRINT "       3.  [V/m]ý"
      PRINT
      INPUT "       Selection (1-3)? ", UnitChoice$
    LOOP UNTIL (UnitChoice$ >= "1" AND UnitChoice$ <= "3")
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Setting unit type..."
    PRINT #1, "U"; UnitChoice$; CHR$(13)
    SLEEP 1
    Result$ = ""
    DO WHILE NOT EOF(1)
      Unit$ = INPUT$(1, #1)
      Result$ = Result$ + Unit$
    LOOP
    IF INSTR(Result$, ":E") = 0 THEN
      PRINT "       Unit set successfully"
    ELSE
      PRINT "       An error has occurred in setting the unit"
      INPUT "       Press Return to continue ", Continue$
    END IF
    PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines let the operator select whether they want
REM ** single readings or continuous data from the probe.  Currently,
REM ** the delay between readings is 1 second, but if more rapid readings
REM ** are needed, the sleep command may be replaced with a for loop like
REM ** this:  FOR I = 1 to X : NEXT I
REM ** where "X" is some number which may vary.  Note that too short of a
REM ** delay will cause erratic program behavior and possible buffer
REM ** overflow.
REM **
ReadData:
    DO
      CLS
      PRINT : PRINT : PRINT
      PRINT "       1.  Single sample"
      PRINT "       2.  Continuous samples"
      PRINT
      INPUT "       Selection (1-2)? ", ReadChoice$
    LOOP UNTIL (ReadChoice$ = "1" OR ReadChoice$ = "2")
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Reading field measurement from FP4000..."
    PRINT
    SELECT CASE ReadChoice$
      CASE "1"
        PRINT #1, "D2"; CHR$(13)
        SLEEP 1
        Result$ = ""
        DO WHILE NOT EOF(1)
```

```
        ReadData$ = INPUT$(1, #1)
        Result$ = Result$ + ReadData$
      LOOP
      PRINT "       Reading from FP4000:  ", Result$
    CASE "2"
      DO
        PRINT #1, "D2"; CHR$(13)
        SLEEP 1
        Result$ = ""
        DO WHILE NOT EOF(1)
          ReadData$ = INPUT$(1, #1)
          Result$ = Result$ + ReadData$
        LOOP
        LOCATE 6, 1
        PRINT "       Reading from FP4000:  "; Result$
        PRINT "       Press ESC to stop readings."
      LOOP UNTIL INKEY$ = CHR$(27)
  END SELECT
  PRINT
  LOCATE 24, 1
  INPUT "       Press Return to continue ", Continue$
  RETURN

REM **
REM ** the following lines allow the operator to type a number (in seconds)
REM ** of inactivity that the FP4000 will wait before entering sleep mode.
REM **
SleepTimer:
  CLS
  PRINT : PRINT : PRINT
  PRINT "       Sleep Timer"
  PRINT
  PRINT "       Enter time in seconds to wait for a command before"
  INPUT "       putting the probe into sleep mode:  ", SleepTime$
  CLS
  PRINT : PRINT : PRINT
  PRINT "       Setting sleep timer..."
  PRINT
  PRINT #1, "S"; SleepTime$; CHR$(13)
  SLEEP 1
  Result$ = ""
  DO WHILE NOT EOF(1)
    Sleep$ = INPUT$(1, #1)
    Result$ = Result$ + Sleep$
  LOOP
  IF INSTR(Result$, ":E") = 0 THEN
    PRINT "       Sleep timer set successfully"
    PRINT "       A setting that is too low will cause erratic "
    PRINT "       program behavior.  A reccommended setting is"
    PRINT "       around 100."
  ELSE
    PRINT "       An error has occurred in seeting the sleep timer"
    INPUT "       Press Return to continue ", Continue$
    GOTO SleepTimer
  END IF
    PRINT
```

```
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines allow the operator to choose between a baud
REM ** rate of 2400 or 9600 for the next power up.  Note that this program
REM ** opens the serial port for 9600 baud, so if 2400 is desired, the
REM ** OPEN statement in the setup routine at the beginning of this
REM ** program must be modified to accomodate for the baud rate change.
REM **
BaudRate:
    DO
      CLS
      PRINT : PRINT : PRINT
      PRINT "       Select a baud rate"
      PRINT
      PRINT "       1.  2400"
      PRINT "       2.  9600"
      PRINT
      INPUT "       Selection (1-2)? ", BaudChoice$
    LOOP UNTIL (BaudChoice$ >= "1" AND BaudChoice$ <= "2")
    CLS
    PRINT : PRINT : PRINT
    PRINT "       Setting baud rate..."
    PRINT #1, "C"; BaudChoice$; CHR$(13)
    Result$ = ""
    DO WHILE NOT EOF(1)
      Baud$ = INPUT$(1, #1)
      Result$ = Result$ + Baud$
    LOOP
    IF INSTR(Result$, ":E") = 0 THEN
      PRINT "       Baud rate set successfully."
      PRINT "       Note that the baud rate does not change until the"
      PRINT "       FP4000 has been powered down (turned off), let sit"
      PRINT "       for at least 10 seconds, and then powered up again."
      PRINT "       Also note that this program configures the serial "
      PRINT "       port to communicate at 9600 baud.  If you wish to "
      PRINT "       operate the FP4000 at 2400 baud, you will need to "
      PRINT "       Change the OPEN statement to be as follows"
      PRINT "       OPEN 'COM1:2400,O,7,1,RS,CD0,DS0'"
    ELSE
      PRINT "       An error has occurred in setting the baud rate"
      INPUT "       Press Return to continue ", Continue$
      GOTO BaudRate
    END IF
      PRINT
    LOCATE 24, 1
    INPUT "       Press Return to continue ", Continue$
    RETURN

REM **
REM ** the following lines initialize sever program variables
REM **
InitVar:
    MainChoice$ = ""
```

```
    Result$ = ""
    Voltage$ = ""
    TempChoice$ = ""
    Temperature$ = ""
    Zero$ = ""
    XAxis$ = ""
    YAxis$ = ""
    ZAxis$ = ""
    AxisSend$ = ""
    Axis$ = ""
    RangeChoice$ = ""
    Range$ = ""
    UnitChoice$ = ""
    Unit$ = ""
    ReadChoice$ = ""
    ReadData$ = ""
    SleepTime$ = ""
    Sleep$ = ""
    BaudChoice$ = ""
    Baud$ = ""
    RETURN

REM **
REM ** the following lines close the serial port and end the program
REM **
Quit:
    CLS
    CLOSE
    END
```

8.0 SCHEMATICS